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CADASTRAL SURVEYS IN THE
UNITED STATES

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CADASTRAL SURVEYS IN THE UNITED STATES

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Let me begin with a definition by the Pan-American Institute of Geography and History, published by the United Nations in the document entitled "Modern Cartography, Base Maps for World Needs, 1949."

Cadastral surveys in general create, reestablish, mark and define boundaries of tracts of land. Such surveys, unlike scientific surveys of an informative character which may be amended with changing conditions or because they are not executed according to the standards now required for accuracy, cannot be ignored, repudiated, altered, or corrected, and the boundaries created or reestablished cannot be changed so long as they control rights vested in the lands affected.

The official record of a cadastral survey ordinarily consists of a drawing or map and a written description of the field work. The drawing represents the lines surveyed showing the direction and length of each of such lines; the boundaries, description and area of the parcel of land; and, as far as practicable, a delineation of the topography of the region, including a representation of the culture and improvements within the limits of the survey."

Cadastral surveys of the public lands are made for official purposes. The plats and field notes constituting the permanent records, furnish the basis for the identification and description of particular tracts of land for primary disposal or for administration by the appropriate governmental agency. The plats are filed in a public office of record.

The U. S. Supreme Court, in commenting on the significance of the plat, said:

It is a well-settled principle that when lands granted according to an official plat of survey of such lands, the plat, itself, with all its notes, lines, descriptions and land marks becomes as much a part of the grant or deed by which they were conveyed, controls so far as limits are concerned, as if such descriptive features were written out upon the face of the deed or grant itself." (Cragin v. Powell, 128 U.S. 691)

It is not the purpose of this paper to describe the origin and history of the rectangular system of surveying the public lands of the United States. Nor do I plan to present material readily available in the publications of the Bureau, or in text books on surveying, but will discuss certain phases of cadastral surveying related to the present activities of the federal agency I serve, the Bureau of Land Management of the Department of the Interior.

The Bureau of Land Management, established July 16, 1946 through

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consolidation of the General Land Office and the Grazing Service, is responsible for the management, leasing and disposal of the public lands and their resources. The Bureau administers the laws relating to these lands, including the mining and mineral leasing laws, and supervises grazing and forest conservation. Its operations are divided into six basic divisional activities: Cadastral surveys; land classification, planning and adjudication; minerals; range management; forestry; and administration.

Completion of Original Surveys

A major objective is the completion of the original surveys in the continental United States involving over 100 million acres of public lands. The identification and monumenting of the boundaries of the remaining unsurveyed areas which are intermingled with privately owned lands is a necessary preliminary to the management operations of this and other Federal agencies.

The Western States contain large areas of unsurveyed public lands ranging from 24,000,000 acres in Arizona to 2,500,000 in Wyoming. Since the school land grants become effective upon acceptance of the official surveys, these states are vitally interested in the accomplishment of this objective. The individual applicant who desires to acquire or lease a tract of public land finds that the identification of the land is the first requisite.

In Alaska, only a minor fraction of the Territory's total area of 365,480,000 acres is surveyed. It is recognized that the rectangular net of the public land survey system will never be extended over large areas of the Territory, since climatic, economic and topographical conditions are such that this type of survey will not be required. However, there is a continuing need for surveys of various types in localities where development and settlement are taking place. A major problem in Alaska is the proper connection of these isolated surveys to the public land survey system or to a station of the U. S. Coast and Geodetic Survey.

Two essential requisites of the cadastral survey are permanent monumentation and adequate accuracy. Modern practices represent a great improvement over early land surveying methods. Corner monuments are wrought iron or copper-bearing steel pipe with a concrete core and a brass cap. With the planted end of the post split to form a flange, the pipe is set solidly two feet in the ground. This has been found to be a very durable monument under nearly all conditions.

The development of an improved model of the solar transit with the Smith solar unit mounted on one standard has made possible the rapid and accurate determination of astronomic azimuth. This type of solar unit permits the use of the main telescope without changing the settings of the latitude and declination arcs and makes it possible to take frequent observations without loss of time.

In the hands of an experienced operator, an independent determination of the true meridian may be made in a period of less than two minutes with an accuracy equal to that of any single direct altitude observation on the sun. The great advantage of this instrument lies in the fact that in running lines through timber and undergrowth, twenty to thirty or more independent azimuth determinations per mile can be made without clearing the line for back sights. In such cases, the bearing between corners is the result of a mean of the total number of observations.

The instrument has been standard equipment for fifty years and has been

continuously improved during that period very largely through the research and professional ability of Mr. Arthur D. Kidder, who is well known to all of you as a member of this Division's Committee on Land Surveys and Titles. Another member of this committee who has contributed greatly to the development of the solar transit during this period is Mr. Joseph C. Thoma. Mr. Kidder is now serving as Commissioner of the U. S. Supreme Court on the resurveys of the boundary between Colorado and New Mexico.

Resurveys

Resurveys of public lands are an important part of cadastral engineering activities. As you know, more than half of the area of the eleven Rocky Mountain and Pacific Coast States are public lands. Although two-thirds of this area has been covered by the original surveys, much of the territory was surveyed prior to 1910 under the contract system. The early surveys were carried on in advance of settlement in an undeveloped wilderness. The existing conditions called for speed and the land values did not justify a high degree of accuracy. The section and quarter-section corners were marked with wooden stakes or stone. With the passage of time, much of the existing evidence of these early surveys disappeared.

Obviously, comprehensive restoration of these original surveys is essential for the identification of the public lands and the privately owned lands which are intermingled with them. Resurveys in the Western States have constituted more than 50 per cent of the annual survey program of the Bureau for many years. This continuing program includes public lands under the jurisdiction of other federal agencies, such as the Bureau of Indian Affairs, Bureau of Reclamation, Geological Survey, National Park Service, Forest Service, and others. All require carefully executed and permanently monumented cadastral surveys for adequate administration of the lands under their control.

One of the problems of the topographic engineer is horizontal control, and another is the proper representation of the public land survey net on the topographic map. Present-day cadastral surveys and resurveys are of third order accuracy. Consequently, the established monuments are adequate for horizontal control and are used for this purpose by the Geological Survey. They also give complete and authentic data on the land survey net.

In the case of the early public land surveys, the topographer is often confronted with the twin problems of widespread obliteration and relatively large errors. Frequently, only a limited number of the section or quarter-section corners can be definitely identified. The land net must necessarily be shown upon the topographic map based upon such limited control with consequent uncertainty as to the correct position of the section lines where no corners are found. If the existing corners are not in good record relation to each other, substantial errors in the position of the section lines could result. For accurate representation of the land net on large-scale topographic maps under such conditions, a complete resurvey involving recovery of all existing evidence of the original survey, combined with proper restoration of missing corners, is required.

A general recognition by federal mapping agencies of the importance of complete and accurate identification of the public land survey network by an authorized agency is a relatively recent development. It has resulted in requests from these Bureaus for resurvey procedure by our surveying organization to be undertaken before the topographic field work or aerial

photography is begun.

On the Missouri-Souris Reclamation Project in North Dakota where the Bureau of Land Management resurveyed over 3,200 square miles for the Bureau of Reclamation, an interesting test was made to determine the accuracy of the bearing and distances of the cadastral resurveys executed in 1946, 1947, and 1948, using as a standard the control system established on the same area by the U. S. Coast and Geodetic Survey. The cadastral survey traverses along the section line were connected with accurate field ties to the U. S. Coast and Geodetic Survey triangulation stations from the nearest public land survey corners. The errors of closure based upon the comparison with the position computations of the U. S. Coast and Geodetic Survey were found to range from 1:3996 to 1:35000 with an average closure of 1:10824 for seventeen separate tests.

Meander Lines and Riparian Rights

In the extension of the U. S. cadastral surveys, all navigable bodies of water and other important streams and lakes are segregated from the public lands at ordinary high-water elevation. Coastal waters, including the beds of all tidewater bays and streams, are segregated at ordinary high tide. The traverse of the margin of a permanent natural body of water is called a meander line.

The courts have held that generally meander lines are not boundaries but are surveyed for the purpose of defining the position of the shore line and to serve as a basis for computing the area of the fractional subdivision abutting such line. The ordinary high-water line itself is the boundary and when it changes gradually, ownership of the adjoining land changes with it. However, if a boundary stream suddenly abandons the old bed and seeks a new channel by the process known as avulsion, the boundary remains as it was in the center of the old channel.

An interesting case of avulsive change occurred on the Colorado River near its confluence with the Gila just above the city of Yuma, Arizona. On June 8, 1820, during a period of extreme high water the Colorado broke through its channel into that of the Gila, cutting across the neck of a large oxbow and shortening the channel from 11 miles to about 4 miles. Since the middle of the Colorado River forms the boundary between the States of Arizona and California, location of the State Boundary was at issue because of this channel change. The Assistant Secretary of the Interior held that the State Boundary and the boundary of the Yuma Indian Reservation remained in the center of the abandoned channel. The final surveys define and monumented the center of the old abandoned channel as the official boundary of the Yuma Indian Reservation.

Upon the admission of a State into the Union the title to all lands under the inland navigable waters within the State inures to the State as an incident of sovereignty and the laws of the State govern the extent of the riparian rights of the shore owners. With respect to public lands bordering on non-navigable bodies of water, the Government assumes the position of a private owner, and when it parts with its title to those lands, without reservation or restriction, the extent of the title of the patentee to the lands under water is governed by the laws of the State within which the lands are situated.

The property right of the riparian proprietor is an important, and often a very valuable one, which is recognized and defined by the courts. The

existence of such rights raises the problem of the proper division thereof among the various adjoining proprietors. The federal rule in the division of accretion is to apportion the new frontage along the water boundary in the same ratio as that of the fractional subdivisions along the record meander line. Where the division of the bed of a non-navigable lake or stream is involved, the partition lines are run from the property line on the bank or shore line to points on the medial line of the lake or stream at right angles to the medial line. Where abrupt changes in the course of the medially line are developed, the apportionment of points along said medial line between acceptable normals may be required.

Many islands in meandered streams and lakes were not surveyed at the time the original township surveys were made. Even though the United States may have disposed of lands on the adjoining mainland, an island in a meandered body of water, navigable or non-navigable, in existence at the date of the admission of a State into the Union and at the date of the survey of the mainland, if omitted from the original survey, remains public land and is subject to survey.

It is an established rule of the Bureau that where an approved plat purports to show that all public lands within the limits of a township have been surveyed, it raises a strong presumption that no public lands were omitted from survey. No additional surveys are thereafter allowed except upon proof of the existence of the lands at the dates above referred to. Before such surveys are undertaken, the regulations require that the adjoining land owners and the state authorities be notified.

An important exception to the general rule that a meander line is not a boundary is found where an original survey was fraudulent or grossly inaccurate in that it purported to show tracts of public land bordering on a body of water, when in fact no such body of water existed at or near the so-called meander line. In such case, the record meander line becomes the boundary of the lands originally surveyed and marks the limit of the disposal of the fractional lots bordering thereon. The Government may survey and dispose of any omitted areas as public land. A field investigation of the soil, topography, timber and culture is made and testimony by local residents, surveyors, and land owners is taken. If it is demonstrated that the areas in question are actually omitted public lands, a survey is executed in accordance with accepted practice.

Special Types of Surveys

The rectangular system of surveys has been extended over most of the original public domain. However, this system is not the basis for the primary disposal of all public lands. Various types of special surveys have been authorized by law for the disposal of particular classes of lands. The private land claims, embracing lands granted to individuals by foreign governments prior to the acquisition of the territory by the United States, were irregular tracts surveyed by metes-and-bounds. Mining claims, forest homestead entries, Alaska homesites and other claims with irregular boundaries are surveyed by metes-and-bounds under requirements prescribed in the Manual of Surveying Instructions.

Mineral surveys are made to determine and mark the boundaries of lode mining claims for patent purposes. They are made by qualified mineral surveyors who are commissioned by the Regional Administrator to undertake

surveys of this character. These mineral surveyors are not employees of the Bureau but make such surveys by contract with the applicant and at his expense, subject to approval by the authorized official of the Bureau.

The survey conforms with or is embraced within the lines of the mining location as staked out by the applicant. The bearing and length of the lode line or presumed course of the vein is noted. Measurements are in the foot unit and limits of closure are 1 to 2000. Connection is made by bearing and distance from a corner of the mineral survey to a corner of the public land rectangular survey if the latter is within two miles; otherwise, a mineral location monument is established on some prominent point.

Mineral segregation surveys involve the segregation of unsurveyed lode mining claims in a surveyed township from the remaining public lands. While it is necessary to make a metes-and-bounds survey of the mining claims with connections to corners of the public land survey, as is done in the case of mineral surveys, the purpose of the mineral segregation survey is to furnish designation and area for the fractional public land subdivisions outside of the mining claims. Field work also involves the resurvey of the section boundaries. Measurements are made or converted to the chain unit for representation on the supplemental plat showing the fractional subdivisions. Surveys of this type are made by cadastral engineering employees of the Bureau.

The public land laws provide for the reservation and classification of lands for townsite purposes where the urban or suburban character of the area justifies such procedure. The term "townsite survey" is applied to the laying out and marking of the blocks, streets, alleys and parks within one or more sectional subdivisions. In some cases these townsites are designed to create new building sites on vacant land; in others, established trading posts, villages and towns require the planning of street lines, block and lot boundaries to protect existing improvements.

Preliminary steps usually include examination of the area together with a topographic survey to determine locations of improvements, appropriate street layout, street grades, and adequate provision for railroad and highway right-of-way, including station grounds. The resurvey of the boundaries of the section in which the townsite is situated together with the subdivision thereof in accordance with manual procedure follows.

The regulation 2-inch iron brass-capped post or similar monument is used to permanently monument the angle points on the townsite boundary lines, intersection of street center lines, and such other points as will furnish adequate and consistent control for the establishment and restoration of all block corners. Hardwood stakes are employed to mark block and lot corners.

Lengths and bearings of street center lines, blocks and lots are determined by survey. Complete field data, including dimensions of irregular blocks and lots together with the necessary elements for circular curves, are indicated on the plat. The survey of the townsite boundaries is made with sufficient accuracy to secure a closure with an error of not to exceed 1/5000.

Foreign Technical Assistance

All of these ideas which I have been discussing with you are now becoming a part of world exchange among engineers who are being called on to use their knowledge not only to better conditions in this country but in other lands. A notable development since the close of World War II has been the increased

interest of many countries throughout the world in the development of their natural resources and the prevailing view of many of their officials that this country is able to help them with their problems. Specialists of the Bureau of Land Management, in such fields as cadastral surveys, land titles and records, and range and forest management, have participated in foreign technical assistance programs. Leonard Berlin, Regional Chief, Division of Cadastral Engineering in Alaska, spent a number of months in the Philippine Islands advising and assisting the officials of the Government on survey problems. Cadastral Engineer Marvin Lytle, of the Portland, Oregon, Regional Office, was in Germany on a similar mission. Requests for technical aid of this type continue and similar assignments in South America and elsewhere are in prospect.

The Bureau has participated to some extent in international conferences in other parts of the world. Earl G. Harrington, Chief, Division of Cadastral Engineering, represented the Bureau at the Conference of British Commonwealth and the United States at Wellington, New Zealand, recently. Numerous foreign officials and engineers visiting the United States have studied the activities and practices of the Bureau on resource development both in Washington and in the field.

Land Subdivision and Property Surveys

Although the Bureau of Land Management is taking an active part in this exchange of ideas among engineers from all over the world, our first responsibility must always be that of getting the job done here in the United States.

We have discussed the cadastral survey of the public lands which has provided the basis for original disposal. The patent to a tract of public land issued by the United States to an individual, corporation or State based upon the official plat of such survey, constitutes the first step in the chain of title running down to the present owner of any part of the original tract.

The licensed engineer or land surveyor located in one of the public land states has the problem of ascertaining the boundaries of a parcel of land embraced in the valid claim of a proprietor not only in relation to the boundaries of the adjoining land owners but also in relation to the boundaries of the public land subdivisions included in the original patent. The location of such a parcel of land must fall within the limits of the original public land subdivisions described in the patent in order to justify the claim of title.

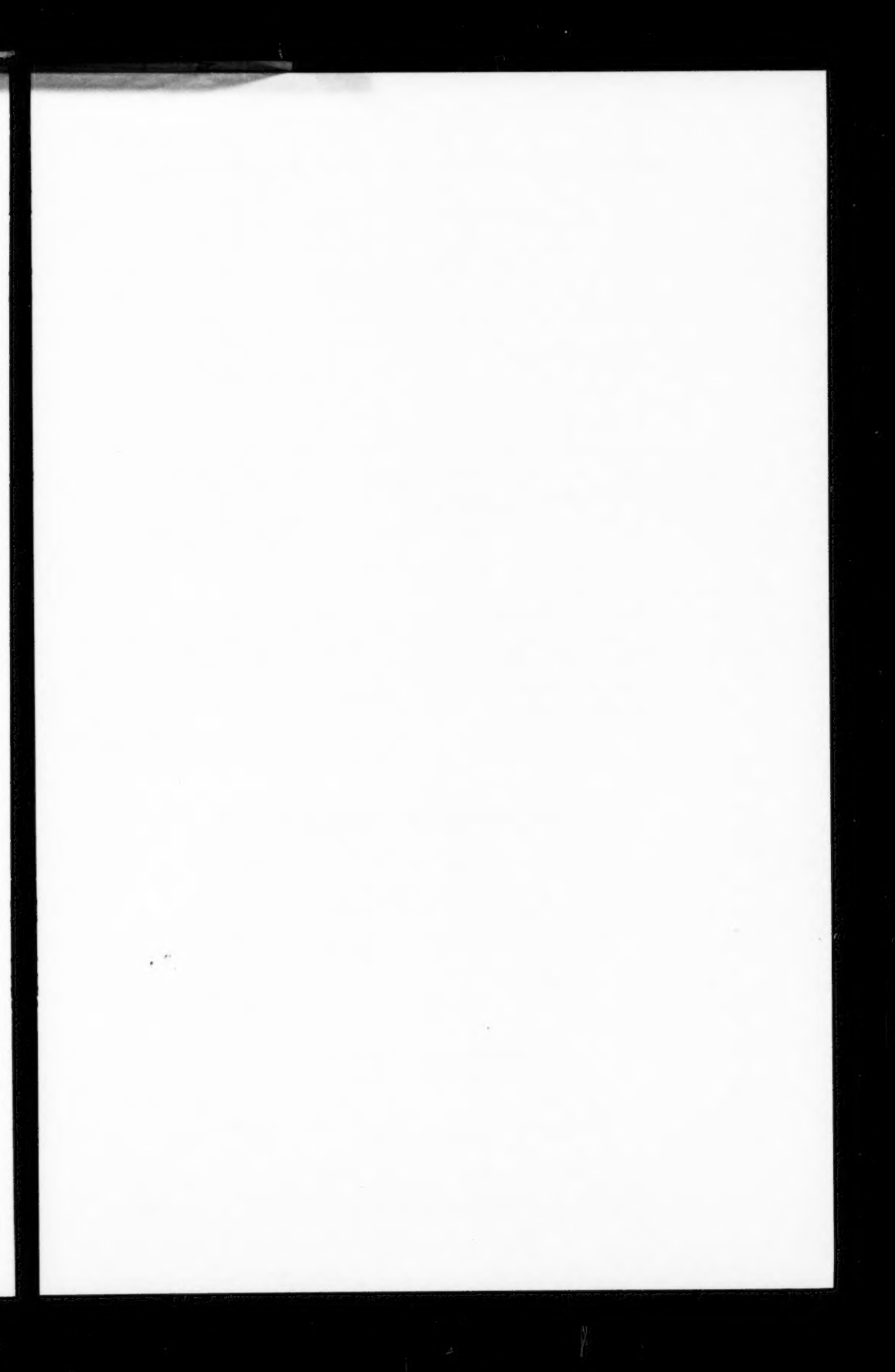
The expansion of the suburbs of large cities and the subdivision of adjacent rural areas into relatively small units has increased the need for controlled cadastral surveys. This situation is generally recognized by engineers in this field. A problem that is not so clearly understood is the necessity for a comprehensive and precise identification and marking of the public land rectangular survey net upon which the original titles are based. After the section lines have been identified, either by evidence of existing corners or restoration by proper resurvey procedure, these lines should be integrated into a controlled cadastral survey extending into the urban and suburban areas so that a proper relationship between the urban and the rural types of development can be determined.

One of the difficulties in connection with property surveys is the fact that the real estate developer and the title attorney are primarily and immediately concerned with title and description, while the surveyor's basic problem is the actual location of the tract on the ground and the marking of its boundaries.

The land owner may fail to realize that a valid deed containing a competent description of the lands does not afford him complete protection. The document may correctly describe the boundaries and state how they should be determined, but the actual locating and marking of these boundaries on the ground must also be considered. The latter procedure often encounters unexpected difficulties because of discrepancies between the bearings and lengths of lines recorded in the deed and those actually found on the ground.

Many of these problems could be resolved by the development of regional and county planning to coordinate the street, block and lot subdivisional systems of the municipal areas with the public land survey net in the outlying rural areas by adequately controlled cadastral surveys. The intervening suburban regions could be subdivided in a manner appropriate to the character of development. Cadastral plats showing designation and area for the subdivisional units (block and lot numbers, for example) filed as a public record would afford the best type of deed description. Since modern title procedure places responsibility on the recorded document, greater emphasis must be placed on the proper recording of the official cadastral survey upon which the title is based.

Most of the states provide by law for the registration of engineers and land surveyors; the recording of the field notes and plats of property surveys; and the approval and recording of cadastral plats of cities and towns. Engineers can benefit the community and themselves by studying existing legislation on the subject with a view to improvement of present practices in property surveying. The Committee on Land Survey and Titles of the Society's Surveying and Mapping Division has already considered some aspects of these problems and I hope will make recommendations to the Society concerning ways and means of accomplishing this purpose.



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